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THE LEAD POISONING PROBLEM IN THE FOUR FLYWAYS

Knowledge about lead poisoning is divisible into three parts: what we know, what we think we know, and what we don't know. Among the things we know is that most species of wildfowl, when given the opportunity, will pick up and swallow lead shot pellets. Once ingested, one or more lead pellets when eroded by gizzard action can kill a duck or goose. Under certain conditions heavy losses among waterfowl may occur from lead poisoning in relatively small areas. Added to these knowns is the growing realization that we can no longer afford to permit such wastage of waterfowl. All savings count, and lead poisoning constitutes a drain on the resource which we could well do without.

Less certain is our knowledge of the over-all effects of this malady, an uncertainty which is excusable because the problem is complex. For example, among the various species, mallards are more susceptible than some other kinds of waterfowl. Furthermore, wild mallards are more susceptible than tame mallards and old mallards more than young ones. Diets and stresses (such as cold or lack of food) have a bearing on whether the bird dies or survives. Above all, the availability of toxic shot varies from place to place, depending on the number of shells fired, and it varies from time to time, depending on water depth, type of bottom and perhaps other factors.

Frank C. Bellrose of the Illinois Natural History Survey has done the best job to date in putting the lead poisoning problem in perspective.* He used a combination of stomach analyses, fluoroscopy, and controlled feeding to arrive at a measure of the losses in various parts of the country. His findings leave little room for doubt that the problem is widespread and important. Certainly no one has produced information contrary to this conclusion. But we still have to place this information in the "what we think we know" category because of the difficulties mentioned.

There are many things we do not know about lead poisoning. Most important, we have devised no practical means of eliminating or even reducing this mortality factor. We know very little about the side effects when leaded birds recover. We know too little about how long lead shot remains available to waterfowl in various soil types or how to eliminate lead at existing trouble spots.

Periodically in the past, lead poisoning has been identified as an important problem needing a solution. Considerable effort already has gone into seeking a solution but obviously not quite enough. This time several conservation groups working closely with industrial experts, are determined to find an answer which can be measured in terms of birds saved.

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*See Bellrose, Frank C. 1959. Lead poisoning as a mortality factor in waterfowl populations. Ill. Natural History Survey Bul. Vol. 27, Art. 3.

One phase of the present study involved the solicitation of comments regarding lead poisoning from various parts of North America. More than 300 reports have been received. We have extracted pertinent information from these reports and prepared the following summarization, grouped by flyways.

Sources of Information

Early in 1964 the Bureau's Regional Offices distributed a questionnaire to their field stations requesting information on the presence or absence of lead poisoning. Similar information was collected through the flyway councils, from State waterfowl personnel and from others. This approach was used to update similar information collected by Bellrose nearly a decade ago.

The reports provided us with much useful information concerning the lead poisoning problem. By piecing them together, a general, although minimal, picture emerges of the problem's over-all importance.

Results of a survey of this kind, however, can not be taken at face value. A negative report, for example, did not necessarily reflect the presence or absence of the problem in a given area for a variety of reasons. Reports were received from fish hatcheries, refuges, and other places where there was no opportunity for lead to accumulate. Some reporters lacked the experience to recognize the disease. Others were new in the area on which they were reporting. This was evident in several cases, when two or more individuals reported on the same area, but their observations and conclusions did not agree. Even reports from laboratories, including diagnoses for diseases and foods, cannot be accepted without reservation. These examinations sometimes ignored lead or lead poisoning.

Few reports were based on specific studies designed to show the presence or absence of the lead poisoning problem. Large-scale die-offs usually attract attention but lesser losses usually go unnoticed.

These points should be remembered when evaluating the reports which follow. Also, bear in mind that wildfowl are extremely mobile, hence a single contaminated area along a flight route otherwise "clean" may produce a fatal case of lead poisoning. About three-fourths of the reports were negative but this should not mislead us as to the over-all potential of the problem.

ATLANTIC FLYWAY

Ontario

Essex County, March 1953. "...large numbers of canvasbacks were found in a dead and dying condition in the River Canard Marsh.. Five..sent to our Research Station--had typical lead poisoning symptoms."

Victoria County (Pigeon Lake) 5/3/55. "...approximately 2000 (greater scaup) in the raft---were not able to fly or dive. Residents in the area reported many dead birds found along the shore of the lake. Seven of these birds were delivered to the Southern Research Station for examination and five of these showed lead shot in the gizzard.. All birds examined while alive showed typical symptoms of lead poisoning. A subsequent toxicological report indicated the presence of heavy abnormal concentrations of lead in the liver, kidneys, and ingesta---."

Kent County (Rondeau Marsh) 4/30/56. "..Approximately 200 dead and dying redheads and canvasbacks--some of these birds were found to have lead shot in the gizzard and it was assumed that this die-off was caused by an outbreak of lead poisoning."

Victoria County (Pigeon L.) 5/7/57..involving a flock of about 1500 scaup- "...Some fourteen of these birds were collected and examined clinically at the Ontario Veterinary College and it was determined that these birds were suffering from lead poisoning."

Simcoe County - April 1958. "A single greater scaup was found dead---and a clinical examination--revealed that it had died of lead poisoning."

"...it may be [illegible] to note that the greater scaup seems to be the most vulnerable and also the most localized species affected. There are strong indications that the diseased scaup were not exposed to the lead shot in Ontario, and it is now assumed that they must have arrived from somewhere in northern New York State."

"...it is our opinion that this particular problem is not of great concern in Ontario at the present time since we have no authentic cases in the past few years." (Doug. Roseborough, Ont., Dept., Lands and Forests).

Maine

"...not an important problem in Maine" (H. E. Spencer, Jr., Waterfowl Research Leader).

"We should not expect that ring-necks would be as likely to acquire lead shot while they are in Maine as they would farther south, where they feed in areas subjected to much heavier shooting pressure. Nevertheless, 3 out of

90 stomachs examined were found to contain lead pellets." (Mendall, 1958)*

Negative reports from Moosehorn NWR** and GMA at Augusta.

New Hampshire

"To the best of my knowledge lead poisoning does not occasion the loss of any birds in this State and no problem exists in this regard.." (H. C. Lacaillade, State Game Biologist).

"I do not feel lead poisoning is an important factor in New Hampshire." (H. W. Brown, GMA).

Vermont

About 1955-56, ten lead-poisoned black ducks and mallards were found near Milton. "...some ducks are lost in this area each year due to lead poisoning. Few are actually found or reported..." (B. W. Parker, GMA)

Negative report from Missisquoi NWR.

Massachusetts

1945-49. (Newburyport area). Losses of Canada geese, mostly in the spring, occurred every year. Always found up to 2 or 3 dozen either dead or barely alive. Most of those examined still had lead shot, often 12-15 pellets and one had 73 shots of various sizes. Occasional black ducks with typical symptoms also found, usually in midwinter and early spring." (C. E. Addy, Atlantic Flyway Representative).

"...to my knowledge we have had no mortalities that were traced to this cause." (G. F. Pushee, Jr., State Game Biologist).

"...it is unknown just how significant a mortality factor lead poisoning may be in this section. It may occur locally but be masked by what is considered normal late fall or winter loss ascribed to other causes." (W. R. Forward, Parker River NWR).

Negative reports from Monomoy NWR and GMA at Plymouth.

Connecticut

"Our recorded information...is completely negative. ...some years back there were two or three reports from gunners of shot in the gizzards of birds bagged in the lower Connecticut River." (J. S. Bishop, Fed. Aid Coordinator).

Negative report received from GMA at Haddam.

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*Refers to bibliography on lead poisoning in report dated 5/14/64.
**NWR = National Wildlife Refuge or Refuges. GMA = U. S. Game Management Agent.

Rhode Island

"A 10 year food habits study conducted by the State showed that less than one percent of the duck gizzards contained lead." (W. D. Snow, GMA)

New York

Between January 1939 and January 1944, 172 adult black ducks, wood ducks, and mallards, mostly found dead were autopsied. These were considered "fairly representative of the occurrence of lead in the three species (during that period) i.e., possibly a 2 percent annual loss of adults." Other cases (less typical) 3 canvasbacks with lead, out of 9 examined, 5 greater scaup out of 15 and 3 goldeneyes out of 6. Regular losses occur of wintering waterfowl both upstate and on Long Island. Lead poisoning appears occasionally to be a contributing factor but birds have not always been checked carefully." (Dirck Benson, Senior Wildlife Biologist).

"During the month of April 1963 I had occasion to examine nine Canada geese that died from undetermined causes in Jefferson Co., N. Y... I found lead shot in the gizzards of 5 of the 9 geese and could find no other indication as to what may have caused death." (D. F. Blais, GMA).

"Lead poisoning measurement techniques have been and are still totally inadequate. The gizzards of a very small percentage of the birds which died from unknown causes have been examined and only one--a Canada goose--was found to contain shot." (J. S. Morse, Montezuma NWR).

Negative reports from Iroquois NWR and GMA in the southern district of New York.

Pennsylvania

"Pymatuning area had its first noticeable loss by lead poisoning in the spring of 1961. Approximately 40 Canada geese were lost. Diagnosis was made by personnel of the Patuxent Research Station from examination of 6 birds submitted. One bird had a total of 52 shot pellets. All had in excess of the number to cause death. Dates of outbreaks were March 1961, March 1962, March 1963, and a few birds (estimated 15 Canada geese and 2 swans in spring of 1964). The loss always appears after migrant birds appear in the spring migration. Apparently the loss---at Pymatuning are birds that have wintered in an area where lead pellets are available. After making this much of a northern flight the birds become weak and cannot continue their normal flight. As yet none of our local banded birds have been affected and I feel that the problem is one of the southern wintering range." (Ray Sickles, Waterfowl Mgt. Agent, Penna. Game Comm.)

Pymatuning, May 1962. "I turned four of the birds (of 10 found) over to--the Patuxent Research Refuge and--their gizzards contained from 35 to over 50 lead shotgun pellets. There were approximately 2,000 Canada geese in the area at the time and it is not known how many more birds were affected." (S. T. Miller, GMA).

New Jersey

"...lead poisoning has never been a problem in New Jersey because of the types of bottom involved. Fresh and coastal marshes, bay estuary, and stream bottoms are very soft here and the lead shot sinks in fast.." (R. J. Hawley, GMA)

Negative reports also from Brigantine and Killcohook NWRs.

However, according to Shillinger and Cottam (1937)* in 1936; "..14 ducks from the Delaware Bay region in northern Delaware and southern New Jersey were autopsied. Shot was found in all the gizzards, the number of shot ranging from 3 to 19 per bird."

Delaware

"...for the past five years there has been an annual mortality of about 66 geese from an unknown impaction disease...as some authorities believe these impactions may be an after-effect of lead poisoning." (G. T. Nightingale, Bombay Hook NWR).

"Sick and dead (Canada) geese (50-75) were observed on a fresh water pond at Cape Henlopen, Del., during the last two weeks of February (1964). All the geese were found to have from 1-37 lead shot in the gizzard." (T. R. Gallo and R. Halstead, GMA).

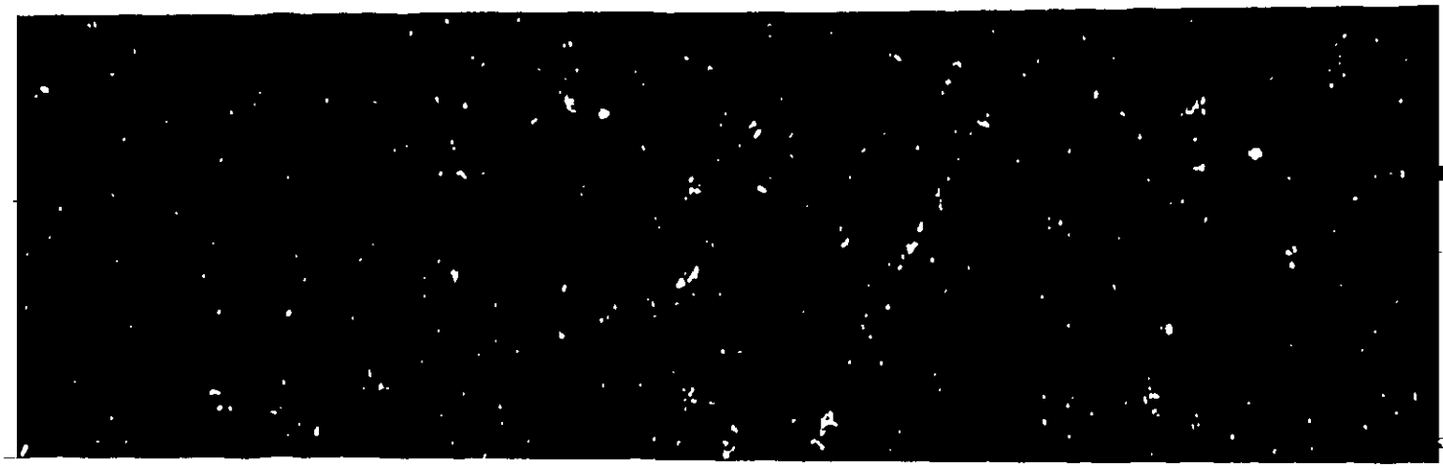
"The only area in Delaware where we have any indications is the Rehoboth Bay area in southern Delaware. All of these determinations were made at Patuxent and will no doubt be included in someone else's report. The date of the only outbreak I have on record here was last February and to the best of our information about 200 birds were lost." (J. L. Harmic, Ass't Dir.)

Maryland

"...several factors peculiar to this area should contribute to quite a bit of lead poisoning even though not reported..some of these blind sites have been consistently shot over for upwards of 200 years. The hard sand bottom characteristic of much of the gunning area of Chesapeake Bay would contribute to the retention of spent shot... In this area, diving ducks are particularly vulnerable to this possibility." (C. Ruiter, Jr., GMA).

"While studying the food habits of waterfowl of Chesapeake Bay in Maryland, considerable numbers of lead-poisoned "sick" birds were observed and examined, particularly along the eastern shore. Most of these were diving ducks with greatest incidence occurring in canvasbacks, redheads and lesser scaup. It is probable that the widespread practice of illegal baiting around off-shore blinds is partly responsible for lead poisoning in this

*See bibliography.



area. Through baiting, diving ducks are lured into feeding in the very areas where largest concentrations of lead shot may be found." (R. E. Stewart, Wildlife Research Biologist).

Negative reports from GMAs at Prince Frederick and Cambridge.

West Virginia

"To my knowledge no case of lead poisoning has ever occurred in the State of West Virginia." (J. A. Donnelly, State Biologist).

Negative report from GMA at Charleston.

Virginia

Currituck Sound, one of the country's most famous shooting areas, was also one of the first places where lead poisoning was reported. Dr. George B. Grinnell accurately described the symptoms of victims in this area in 1901. In 1936, five mallards from Pamlico Sound apparently died from lead poisoning. Shillinger & Cottam (1937).*

"In the Back Bay area of Virginia outbreaks of lead poisoning occur annually and affect (1) Greater snow geese (2) Canada geese (3) Swans (4) Diving ducks.. The past winter losses were light (about 100 birds), but some years the losses run as high as 500-1,000 birds." (D. R. Ambrosen, Back Bay NWR).

Food habit studies conducted by John Sincock (Bureau Biologist) in the Back Bay, Va. - Currituck Sound, N. C. area from 1958-61, showed the following incidence of lead shot in gizzards:

Species	No. examined	No. with shot	% with shot
Black duck	52	13	25.0
Mallard	52	6	11.5
Pintail, Wood duck	54	3	
Baldpate, Gadwall	159	1	
G.W. teal & Shoveler	51	0	
Redhead & Can	19	1	
Ringneck	65	4	6.1
Scaup	24	1	
Other divers	76	0	
Total ducks	552	29	5.2
Canada geese	122	5	4.0

"The Back Bay area is the only one I know of where we have severe outbreaks of lead poisoning...the first outbreak that I know of was from Jan. through March 1956. At this time the principal birds affected were swan, Canada geese, canvasbacks, and redheads (est. about 5,000 lost). The annual snow

*See bibliography.

goose die-off would be between one and five hundred birds - depending where they are feeding. Severe outbreaks of lead poisoning of waterfowl in the area of Back Bay are not likely to occur except during periods of extremely low water, snow geese excepted." (C. P. Gilchrist, Jr., State Biologist.)

"My files do not indicate nor can I personally confirm any waterfowl losses resulting from lead poisoning in the vicinity of Presquile. However, the adjacent Curles Neck Marsh has been heavily shot over many years and there is little doubt that some loss from this disease occurs." (J. H. Roberts, Presquile NWR)

"A number of swans were found on and in the vicinity of Chincoteague Refuge in Virginia in the period 1959-1961 which were believed to have died from lead poisoning." (A. E. Weinrich, GMA)

Negative report from GMA at Onancock.

North Carolina

"Lead poisoning is not a serious problem at this time in the Pea Island Refuge area... Increased use and serious drought conditions could alter these conditions whereby lead poisoning could become an important management problem." (W. C. Good, Pea Is. NWR).

"Mattamuskeet has some losses by lead poisoning each year, mainly Canada geese - a few whistling swans are also affected....large numbers of birds are lost during some seasons (est. 4,000 C. geese in 1960). This could be brought about by low water levels at blind sites or the birds could have picked up the lead during migration. ...we realize that lead poisoning among waterfowl is very serious...and it is hoped that corrective action can be taken in the near future." (W. G. Cahoon, Mattamuskeet NWR).

"Have not encountered lead poisoning in this area of southeast North Carolina. ...this is not a major waterfowl hunting area and (hunting) is not usually concentrated in one area." (C. D. Plant, GMA).

Negative reports from new Pungo NWR and from GMA at Washington.

South Carolina

"We have no authentic reports of lead poisoning in South Carolina..." (F. P. Nelson, State Federal Aid Coordinator).

"I have never encountered any lead poisoning in the ducks of South Carolina. However, this does not mean that there has not been any. We have so many raccoons and other varmints in our marshes that a duck doesn't have to slow down much before something makes a meal of him." (W. C. Lehmann, GMA).

Other negative reports from Cape Romain, Carolina Sandhills, and Santee NWR's and from GMA at Columbia.

Georgia

"If we have lead poisoning it is negligible, however, we have not had any type of study concerning the problem." (R. W. Whittington, State Waterfowl Proj. Leader).

Negative reports received from Savanna, Okefenokee, and Piedmont NWRs and from GMA at Albany.

Florida

Negative reports received from the following areas: South Florida refuges, Lake Woodruff, Merritt Island, St. Marks, and Chassahowitzka NWRs and from GMAs at Sebring and Tallahassee.

Atlantic Flyway Summary

From the information at hand, it is difficult to evaluate the over-all importance of lead poisoning to the waterfowl of this Flyway. There are several known concentration areas (notably Chesapeake Bay, Back Bay, and Currituck Sound, and Mattamuskeet) where lead poisoning is a definite threat to ducks, geese, and swans and where a large part of the flyway's waterfowl population feeds for extended periods. The threat to greater snow geese and whistling swans may be particularly important because the limited wintering grounds of these birds coincides with areas known to have a high potential for lead poisoning. The threat to wintering canvasbacks may also be significant for reasons discussed under Maryland. Locally, at least, black ducks and mallards appear to consume considerable numbers of lead shot. Thus, despite the large number of negative reports...some statewide...the conclusion seems inescapable that lead poisoning is an important mortality factor to the waterfowl of the Atlantic Flyway.

MISSISSIPPI FLYWAY

Manitoba

This Province at the fountrhead of the Flyway, recorded a serious lead poisoning die-off for the first time in the late fall of 1962. This outbreak was well documented. Sportsmen reported that large numbers of ducks, mostly mallards, were dead or dying at Grant's Lake, 20 miles northwest of Winnipeg. The R. C. M. P., Manitoba Game Branch and Manitoba Department of Health immediately collected specimens, conducted x-rays, and examined internal organs and bones of a number of victims. The verdict was lead poisoning and the number of casualties was set at 1,000.

E. J. Bossenmaier, Game and Fur Management Chief for the Manitoba Wildlife Branch had this to say about these losses:

"The die-off appeared to be the aftermath of an unusual chain of events that involved large numbers of mallards exposed to heavy hunting pressure for an extended period into late fall.

"It all started in August when heavy rains flooded large acreages of ripening grain in a low-lying district centered 30 miles north of Winnipeg. An estimated 400,000 mallards were in the flooded district when the hunting season opened in early October. These birds were subjected to constant and heavy hunting pressure in the flooded grain fields. They were not scared out of the area, however, and good hunting continued under unseasonably mild weather past mid-November. Freeze-up came gradually and without deep snow.

Just prior to final freeze-up, the few thousand mallards that still remained were concentrated on Grant's Lake, a shallow marsh in the district, and it is here where the lead poisoning die-off was noted. It appeared all ducks in the district that had become weakened from lead poisoning during the fall on the flooded fields accumulated on Grant's Lake, the last water area to ice over, during the final stages of freeze-up. Grant's Lake itself is a waterfowl refuge and it is unlikely the birds found lead shot there. Heavy hunting pressure, short days, below freezing temperatures and poor field-feeding conditions subjected the birds on Grant's Lake to considerable stress after mid-November."

Minnesota

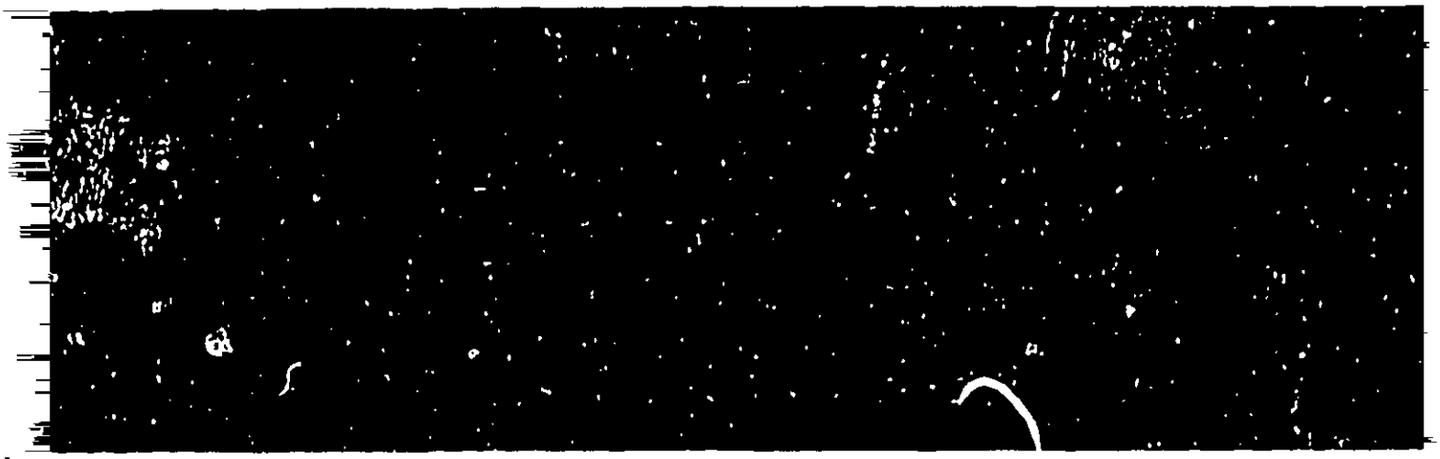
"While dramatic die-offs of ducks from lead poisoning occur on occasion (note Osmer's reference to Heron Lake), these are probably not nearly as destructive as the insidious losses of individuals and small groups." (R. L. Jessen, State Waterfowl Biologist).

This State has made several substantial studies of this problem starting nearly 30 years ago. Some of the findings by Osmer are quoted in a report of the Mississippi Flyway's Planning Committee dated May 18, 1964. This report contains a bibliography referring to published works of other Minnesota researchers including Dowdell and Green, Magath, Fredine and Bell, and Nord. Not included are P-R reports on the incidence of lead shot by Jessen and Lound (1960, 1962) or a food habits study by Kuehn and Holms (1963). All this information points up the problem as it relates to this State.

"Losses became particularly spectacular as water levels receded during the drought years." (C. E. Carlson, Chief, Div. Wildlife Research, Washington, D. C.)

"No major or minor outbreaks of lead poisoning have been observed on Rice Lake Refuge. We do see occasional sick, or injured birds during and following spring and fall migration which in some cases, are believed to be suffering from this infection. The drier the season--the more lead poisoned birds we see on the refuge." (C. R. Alexander, Rice Lake NWR)

"On November 13, 1939, I found the remains of 135 ducks (mostly mallards) which had apparently died of lead poisoning on the Pigeon River Refuge (Chippewa National Forest). Estimated 300 mallards and black ducks died mostly from lead poisoning. Examined 35 drakes and 13 hen mallards which averaged 2.6 shot per duck. During the fall of 1940 on the Chippewa National Forest examined 551 ducks from hunters' bags and 109 or 19.7% contained lead shot. During the fall of 1946 (Upper Mississippi Refuge) 279 gizzards from hunters' bags (Wabasha to Iowa line) 17 or 6.1% contained lead shot. On December 9, 1946, at Mud Lake (S.D.-Minn. line) 350 lead shot were taken from the gizzards of 54 dead mallards." (From field notes of J. H. Stoudt, Bureau Biologist.)



In the midfifties about 16,000 ducks moved into Walnut Lake in Faribault Co., during a warm spell in mid-March. A few days later, winter returned and open water became greatly restricted. Biologists Forrest Lee and Maynard Nelson happened to visit this State wildlife management area and in a short distance found 35 dead ducks and coots. Other sick birds were noted. Gizzards of the victims contained lead shot, presumably picked up, at least in part, before the birds arrived; otherwise, it seems unlikely that they would have died so quickly.

Negative reports from Agassiz and Tamarac NWRs and from Bureau field stations at Fergus Falls, Winona, St. Paul, Mankato, New London, and Grand Rapids.

Wisconsin

Shillinger and Cottam (1937) furnish evidence that lead poisoning problems in the State date back more than fifty years. In April 1909 (when spring shooting was legal) the stomachs of 477 scaup taken near Marquette were examined. It was found that 365 of the birds (76.5%) had consumed 419 lead pellets, an average of 11.5 per bird.

"The attached state map shows the counties where lead poisoning losses have occurred. Major losses are listed on the attached table. Specific sites are listed here for major losses or where frequent losses occur."

Place	Geese	Ducks	Swans
Columbia Co., (Mud L.)	X		X
Dodge Co. (Horicon, Mud)	X	X	
Green L. Co. (Puckaway, Marion)	X	X	
Brown Co. (Green Bay)			X
Winnebago Co. (L. Winnebago)			X
Rock Co. (Rock Prairie, McComb's P.)	X		

Reports have been prepared by Jahn (1949)*, Hartmeister, and Hansen (1949)* and Trainer and Hunt (1964)*. The Wisconsin autopsy files show 576 confirmed cases of lead poisoning involving 1,779 geese with an average of 12.9 pellets per bird; 31 confirmed cases in swans involving 231 birds and

*See bibliography

14.4 shot per bird and 20 cases in ducks involving 215 birds with 12.5 the average number of shot per victim. (Data furnished by R. G. Hunt, State Biol.) Mgr. Carter reported 600 Canadas lost at Horicon NWR during Dec. 1962 and 1963.

"Successive years of drought have reduced water levels to the extent that spent shot are available in virtually all hunted areas this spring (1964). Although no concentrated area of lead poisoning has been found, I believe that general conditions lend themselves to the fact that it is a much more widespread situation than normally exists." (M. L. Stinnett, GMA).

"Dave Hammes, WCD Game Warden, informed me today that he had seen no cases of lead poisoning lately but that he customarily observes it in spring among bluebills." (R. E. Lennon, Chief, Fish Control Lab., LaCrosse, Wis.)

Negative reports from Necedah NWR, Cassville (Up. Miss. NWR), fish hatcheries at Lake Mills and Genoa, and GMA at Eau Claire.

Michigan

According to Pirnie (1935)*: "In Michigan in the spring of 1928, hundreds of migrating ducks died soon after their arrival at Houghton Lake, evidently from the effects of lead poisoning caused by shot possibly picked off the bottom at some southern wintering area or perhaps in front of blinds where baiting had been practiced. ...Van Tyne reported finding an average of nearly fifty shot in each of the gizzards (of 10 greater scaup examined). In April of 1929 the author found 72 shot in the stomach of a dead greater scaup also from Houghton Lake but very few sick birds were noticed." He quotes Dr. O'Roke, an expert on waterfowl diseases, as follows: "Considering the enormous quantity of lead that there must be in the vicinity of blinds that have been shot over for decades, it is reasonable to conclude that the potential danger from lead poisoning is great and should be considered in any waterfowl management program. In the writer's opinion lead poisoning is the disease which takes the greatest toll of adult ducks in this section of the country."

Over the years, Michigan has made several studies which contributed directly or indirectly, to the general knowledge of the lead poisoning problem. One source of information has been the systematic pathologic examination since 1934 of birds sent to Game Pathology Laboratory at Rose Lake. These records do not lend themselves to a quantitative measurement of the over-all importance of the malady but do shed light on its distribution and relative importance by species. For example, there appears to be two major infection points, the lower Detroit River and Lake Erie Marshes of Wayne and Monroe County and the inland lakes of Barry County in the western part of the State. (Two chronic trouble spots are Indian and W. Gilkey Lakes where Pirnie found leaded birds in 1935.) During a 30-year period 225 waterfowl examined by the laboratory had lead shot in their gizzards. Mallards led with 93 cases followed by Canada geese (76), swans (26), and black duck (23). Leaded birds were sent in from Kellogg Sanctuary, Detroit River, Lake Erie, Houghton Lake, Shiawassee Flats, St. Clair Flats, and Saginaw Bay.

*See bibliography.

During the early spring of 1957, 1958, and 1961 losses of Canada geese occurred on Indian and West Gilkey Lakes in Barry County ranging up to several hundred. Erie Gun Club in Monroe County had reported duck losses in 1936 and in 1961 when at least 240 mallards died (82 of 86 examined had lead shot in their gizzards). Swift Lake in 1935 and Proud Lake in 1964 also yielded several lead poisoned geese.

Studies reported by Hunt (19)* showed the following rates of ingested shot in the Detroit area between 1948-1955. Among 10,444 black ducks, canvasbacks, scaup, and redheads live-trapped and fluoroscoped, 335 or 3.2% had shot in their gizzards. Among 2,644 (same species) bagged by hunters and fluoroscoped at Point Mouillee state game area, 121 or 4.6% had gizzard lead. Hunt cautioned, "...this report covers only a local situation and is not to be construed as discouraging a solution to the general problem of lead poisoning losses. On the contrary, I believe every effort should be made to reduce such losses, especially in view of present low duck numbers and the likelihood of increased demands upon this resource in the future."

A sample of 100 scaup taken in the lower Detroit River during the period 12/17/58 - 3/5/59 showed 4% incidence. (From R. H. Town's thesis).

At Shiawassee NWR from 1953 - 1964 the following numbers of birds were listed as lead poisoning victims:

Mallard and black	250
Canada goose	5
Whistling swan	312

(J. W. Ellis, Shiawassee NWR)

State Waterfowl Biologist Mikula views the future outlook as follows: "The problem of lead poisoning in Michigan has been spotty in past years. We are concerned over the potential for outbreaks in established goose areas in southwestern Michigan---. The recent development of goose management areas has created a potential future reservoir for lead poisoning..."

Negative reports from Seney NWR, GMAs at Bay City and Manistique, and fish hatcheries at Charlevoix and Brimley.

Ohio

The following information resulted from an effort by John T. Hutchman, Mgr., Crane Creek State Beach Park, to salvage waterfowl left in the Lake Erie Marshes at the end of the hunting season. From 1960-63 he, with two labrador retrievers, collected 299 birds of 20 species including 12 swans, 2 geese, 255 ducks, and 25 coots. His report shows that: "About 190 of these birds were suffering from lead ingestion." (About a third of the ducks treated in his hospital survived.) "Each spring our area attracts about 3,000 migrating

*See bibliography

whistling swans. I estimate there were between 100 and 150 that died of lead in our area alone. These birds must pick up lead on their wintering grounds and then pick up more as they rest during migration on old established hunting marshes--. Gizzards of 83 waterfowl that apparently died of lead poisoning in the fall of 1963 were examined for lead shot content. Fifteen birds, including all the coots and the pintails had no gizzard shot--. The maximum count was 42 shot in the gizzard of a black duck."

"Lead poisoning has occurred and been verified personally at Winous Point Marsh, Magee Marsh, Ottawa Marsh, and Castalia Blue Hole - all in Ottawa and Sandusky Counties.

Estimated losses:	winter 1950 (Magee)	50 C. geese
	winter 1952 (Ottawa)	100 mallards
	winter 1960-62 (Winous Pt.)	100 C. geese
	winter 1959 (Castalia)	100 blacks and mallards

In the four counties bordering the Sandusky Bay region of Lake Erie, the losses could easily amount to over 1,000 birds annually..." (J. M. Anderson, Winous Point Biologist).

January 1956, Sandusky Co., Ed Metzger's property - 50+ mallards and blacks lost to lead poisoning. "I have a series of 35 mm slides picturing some of the conditions and birds." (F. C. Kniffin, GMA).

"To my knowledge we have had no outbreaks of lead poisoning in the southern section of Ohio. I suspect that an occasional bird does die from this cause but the numbers are not sufficient to have been brought to our attention." (V. C. Conover, GMA).

Negative reports from fish hatchery stations at Hebron, Senecaville, from the River Basins office at Lebanon, and from the Predator and Control office at Columbus.

Indiana

Hovey Lake in Posey County has a history of lead poisoning going back at least until 1922 (Phillips and Lincoln, 1930)*. Mumford (1954)* reported that "...old timers living in the Mt. Vernon, Indiana, area recall when duck die-offs occurred almost every winter at Hovey Lake." He also presents a table showing the incidence of lead in stomachs examined during the period 1949-51. For example, in 1949 among 196 examined, 58 (30%) had lead shot. The computation was made that during the hunting season of 1950 some 1,429 pellets were deposited on the bottom of this lake per duck bagged, at least one quarter ton in all. Flare-ups have occurred periodically since that time. In early 1956 the loss was estimated to be about 1,000 ducks and geese, and as recently as February 1964 an estimated 175 Canada geese were lost before

*See bibliography.

exploders, shell crackers, grenades, rifles, and firecracker ropes dispersed the birds. Thus Hovey Lake exemplifies a chronic trouble area.

Die-offs also have occurred on several occasions at Willow Slough, Newton County, in the northern part of the State. During the winters of 1954-58 losses ranged from about 200 to over 3,000 including both ducks and geese. During those same years annual losses were recorded on Kankakee and Gumz marshes in Starke County.

Some of the more spectacular losses in this State have received considerable attention from the press and have resulted in a considerable file of official correspondence.

Negative reports from the fish hatchery at Rochester and the Predator and Rodent Control station at Lafayette.

Illinois

Bellrose (1959)* mentions two sizable outbreaks of lead poisoning in this State, one near Chautauqua Refuge which killed about 5,000 mallards in early 1957 and one at Stump Lake near Grafton which killed 3,000 mallards in January 1947. Between 1941-1957, some 13,000 ducks reportedly died on or near Chautauqua NWR. In between these dates less spectacular losses occurred annually, although the one of January 1948 on the present Mark Twain Refuge involved 2,500 mallards (E. S. Crozier, Mark Twain NWR).

In December 1948 an estimated 500 mallards and black ducks succumbed to lead at Spring Lake in Carroll County (R. J. Nord, Upp. Miss. NWR).

Referring to the Sny River Bottoms in Pike County, GMAgent A. E. Niemeyer submitted this report dated February 12, 1955: "...with the aid of a Labrador retriever (we) walked the marshes picking up dead and crippled waterfowl. Over a four mile stretch 32 birds were recovered and an estimate made of the remaining dead birds that had been dead too long to be of any use to us. We both arrived at a figure of 1,000 dead in this four mile stretch." The birds were examined in a laboratory and most of them had gizzard lead.

In February 1957 the public reacted strongly about duck starvation "...near Pleasant Hill on the Mississippi River. Instead of several hundred thousand starving as reported, "...An investigation of this report by our Game Agents and Illinois Game Biologists, revealed that in reality only 300 mallards had perished. ...it was determined that the cause of starvation was not due to a lack of feed but to lead poisoning from shot picked up while feeding. (R. W. Burwell, Acting Regional Director, BSFW).

In December 1963 about 200 mallards died on Finch Lake in Mason County (J.W. Hopkins, GMA).

*See bibliography.

At Crab Orchard NWR in southern Illinois, losses of Canada geese due to lead poisoning are greater in some years than the take by hunters and represent 1-2% of the fall population. In 1957-58 the estimated loss to lead was 930 with losses nearly as great in 1962 and 1963. (D. G. Rose, Crab Orchard NWR) According to former Project Manager H. E. Stiles, "...practically every season during the period 1951-62, losses of Canada geese were noted at Crab Orchard. During one outbreak of "crop impaction" 12 live geese were shipped to Patuxent for diagnosis. Only one bird had ingested lead in the gizzard but the livers of all contained sufficient lead residues to cause plumbism. (This emphasizes that the absence of lead particles in the gizzard is an unreliable criterion for the diagnosis of lead poisoning.)

Negative reports from CMAs at Quincy and Anna.

Iowa

Game Biologist Gene Loecke found the following records of lead poisoning in the files:

Year	Place	Losses
1940 or 1941	Round Lake, Clay Co.	500 mallards
1954	Lost Island, Palo Alto Co.	400-500 "
1960	Forney Lake, Fremont Co.	1500 "

"...I do know that Forney Lake---has had a history of lead poisoning in years when the marsh did not freeze over and the birds were there---I do not doubt but what many of the marshes of Iowa do have ducks die from lead poisoning. The numbers are usually small and probably go unnoticed. Areas such as Lake Odessa, Louisa Co., or Goose Lake, Greene Co., surely have ducks die from lead poisoning. In years to come, several of the State-owned marshes will no doubt become lead poisoning kill areas if a new type of shot or other means are not found to combat the problem."

In a letter dated February 21, 1950, Director E. B. Speaker, then Supt., Biology Section, wrote to Frank Bellrose about a die-off on Forney Lake in 1948 involving about 1,500 ducks. He also told of smaller losses on Brenton's Slough (Polk Co.), Carr Lake (Pottawattamie Co.) and Mud Lake (Palo Alto Co.).

About the 1948 die-off, Reis Tuttle, outdoor editor of the Des Moines Register, wrote..."at least 1,000 to 2,500 ducks were dead or dying at Forney's Slough---and hundreds more at Blue Lake farther north.

Severe weather at the end of March 1964 contributed to a die-off on Little Wall Lake, Hamilton Co. Coots, in particular, suffered heavy losses apparently due to starvation. Among 290 coots examined at Iowa State University under Dr. M. W. Weller's direction, none contained lead, but 2 of 19 ducks (7 species) had gizzard shot. Both were ring-necked ducks. Other records on file at Iowa State include 8 ducks and 1 goose received from Forney Lake in early

1961. All but 3 gizzards had lead shot. However, 6 ducks brought in from Kossuth County in 1961 had no gizzard shot.

In January 1964 on Riverton Marsh in Fremont County losses believed to be lead poisoning exceeded 500 mallards. Reporting on this loss GMA W. C. Newcomb said: "...the Forney Lake and Riverton areas both have a history of some lead poisoning each year because they are heavily hunted and both have real shallow water---the Forney Lake area has always been a bad spot for lead poisoning but it was dry this year and so the mallards used the Riverton area a good deal more."

"Lead poisoning is of insignificant proportions in this part of Iowa. In most cases hunting is done in cornfields...." (J. E. Wilbrecht, Union Slough NWR).

On the Louisa-Keithsburg Units of the Mark Twain NWR, R. E. Toltzmann found records in the files showing mallard losses of from 25-400 during the fall of 1949, 1952, 1953, 1954, 1956, 1957, 1962, and 1963. He pointed out that lead poisoning losses may be greater when hunting seasons end early, allowing ducks to feed undisturbed on heavily shot marshes. He concluded, "... certainly many ducks pick up lead on this area (the State's public hunting ground) and (die) on other areas. I do not feel that ducks found in this region are indicative of the amount of lead picked up."

Hamilton and Wright Counties, Big Wall and Little Wall Lakes, 1954-58. Each year there is some waterfowl loss in this area--the incidence of lead poisoning appears to be increasing. I feel that it could become of major importance in over-all so-called "natural mortality" of waterfowl. (C. R. Stribling, Iowa GMA)

On the new DeSoto NWR in January 1964, 25 mallard dead at freeze-up were attributed to lead by Manager K. D. Dybsetter. He commented that "...an absence of loss records in the files does not rule out the possibility that lead poisoned birds have been a mortality factor, since the birds could have been unnoticed in the past."

Negative reports from fish hatcheries at Guttenberg and Muscatine.

Missouri

Over the years several thousand ducks and geese have died on or near Squaw Creek NWR near St. Joseph, Missouri. Heaviest losses were during the winter of 1956-7 when an estimated 10,000 mallards died. Losses between 1,000-2,500 occurred in 1948-49, December 1955, and December 1963. About 500 succumbed during the winter of 1949-50 and lesser numbers annually. While most of the victims were mallards, other species involved were blue-snow geese, Canada geese, green-winged teal, widgeons, pintails, and wood ducks. (H. H. Burgess, Squaw Creek NWR).

"Annual lead poisoning losses at Squaw Creek begin in late December and continue through spring migration--due to the maintaining of water in heavily shot-over marshes around the periphery of the refuge--. The unknown in this case is the number of ducks that succumb off the refuge where inventory is impossible..." (R. W. Vaught State Waterfowl Biologist).

Vaught furnished the following additional information: January 1949 Mo.-Dalton Cut-off (Chariton Co.) 1,000 mallards (96 of 102 fluoroscoped had gizzard shot). Same area March 1960, 500 mallards; March 1960-Miami Bend (Saline Co.) 1,000 mallards. "There are no doubt considerable numbers of mallards lost each year in Missouri due to lead poisoning, but private club owners fail to report because they feel that "the birds are probably cripples."

"In my opinion lead poisoning is a major problem in Missouri because a large part of the waterfowl hunting is done over small artificially created shooting areas. This tends to concentrate the lead around fixed hunting blinds. Although die-offs due to lead poisoning have not been spectacular, I believe the numbers involved to be considerable---. The mortality due to lead poisoning tends to linger for long periods and poisoned birds may travel many miles so that a particular instance of poisoning is never noticed." (W. E. Sanders, GMA).

"There have always been a few mallards lost during the winter here at Swan Lake. When the wintering population is high the losses are high, varying from 100-2,000 mallards and 0-300 Canada geese between 1948-63. (R. H. Timmerman, Swan Lake NWR) (Note: there have been heavier losses of geese than this but they were attributed to crop impaction rather than lead poisoning. The relationship between the two is still uncertain.)

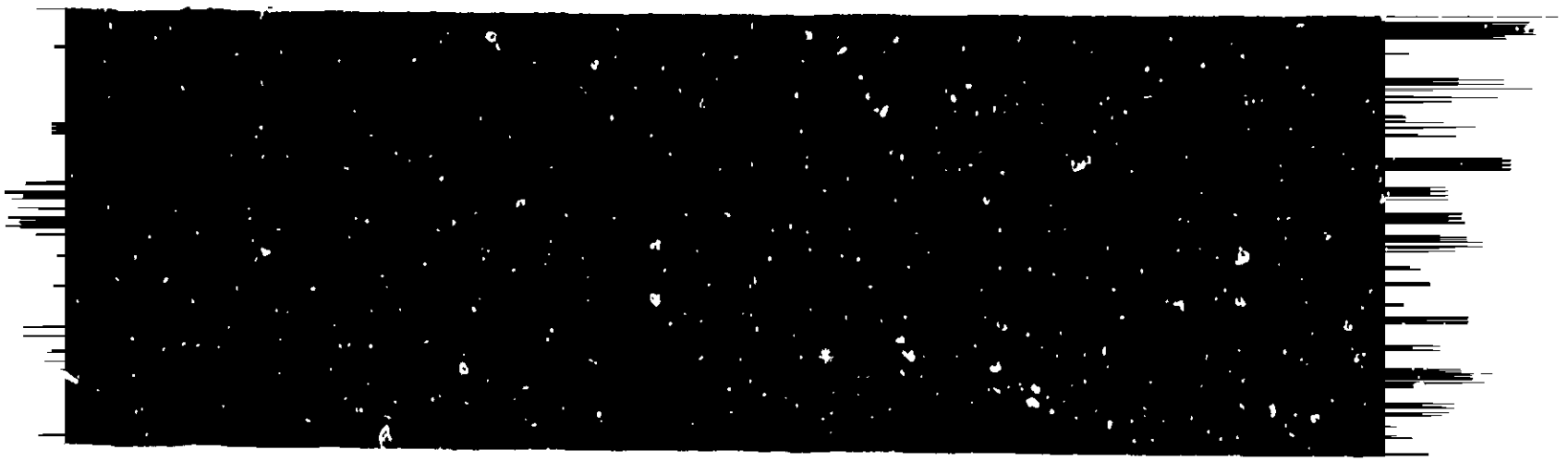
Bellrose (1959) listed a die-off involving 600/ mallards at or near Mingo NWR, 1952-1954, although two reports from that area were negative.

Kentucky

"Ohio River 100-1,500 mallards and Canada geese. This is an annual thing with the birds picking up the shot from Hovey Lake in Posey Co., Indiana. ...Loss seems to be graduated to the amount of rainfall and the lake level; birds are affected, then lake freezes over with resulting movement of birds to the Ohio River. 1962 was the worst period for this area." (W. J. Parker, GMA).

"Paducah area...A few mostly mallards. Not too much of a problem here, as most mallard shooting is done over resting areas (while) feeding is done in the cornfields." (W. B. Lee, GMA).

Negative report from Kentucky Woodlands NWR.



Tennessee

"We have no records of verified losses of waterfowl due to lead poisoning." (C. J. Barstow, Supr. of Waterfowl Mgt.)

However, Bellrose (1959) quoted Parker Smith, then waterfowl biologist for that State, about a case involving 40 or 50 mallards along the Obion River in February 1954.

"...there has been only one known case of lead poisoning at this station since it was established July 23, 1962 and this bird (a wood duck) was found and examined by the refuge manager some six miles from the refuge." (C. L. Ryan, Cross Creeks NWR)

"During the past 3 years a total of four mallard ducks have been found in dying condition. All evidence pointed to lead poisoning." (J. L. DeLine, Reelfoot NWR).

Negative reports from Tennessee NWR and from GMAs at Nashville and Knoxville.

Arkansas

Phillips and Lincoln (1930) stated that "in the Jacobs and Pecan Lake region of Arkansas, large numbers of ducks died from this disease...in January 1925." Clark McAdams, of St. Louis, Missouri, in commenting on this case stated "that while it had not been noted in previous seasons, hunting had been intensive for years, so that the country was undoubtedly covered with shot."

"I remember this (lead poisoning) was common in Arkansas in the early days of the White River Refuge." (R. H. Smith, Pacific Flyway Biologist, biologist at White River Refuge in midthirties.) More recently - "we have noted a few ducks each year that were believed to have died from lead poisoning but their gizzards were not examined to confirm this belief." (R. R. McMaster, White River NWR).

"During the past four years 1952-1956 and before in northeast Arkansas we have had loss of ducks because of what was diagnosed as lead poisoning---. It has been estimated that the number of ducks that have died this year in northeast Arkansas from what seemed to be lead poisoning is about 10,000 ducks---. It has been estimated that the number of ducks that have died this year is about the same as for the 1952-53 and 1953-54 seasons combined--. At any rate, the situation is getting worse each year--the amount of shot becoming accessible may cause the situation to be of major concern to the lower Mississippi Flyway in the next 20 years." (From a report written by J. W. Perkins, GMA).

Later, Agent Perkins after working additional areas with State Biologists Donaldson and Hunter and Bureau Biologist Lynch, upped his estimate to

15-20,000 ducks. Mortality was especially heavy on Claypool Reservoir near Weiner but also occurred at Crain, Chase, Huffman, Rosenwall, Tendall, and Lane Reservoirs. According to Lynch, "...the loss of ducks in the Jonesboro region was most spectacular (but) there is a good possibility that the problem was more serious in the Stuttgart region than we realize, for the same conditions prevailed at both places." He concluded, "there is no doubt that lead poisoning, brought about by the ingestion of lead shot, is in large part responsible for the die-off of ducks in the Jonesboro region. Many specimens showed the unmistakable syndrome of this disease. The region has a bad history of lead poisoning and the low water levels---undoubtedly aggravated the outbreak."

Other bad outbreaks occurred in February 1951 when casualties at Claypool Reservoir "...must certainly number in the thousands," (Report by Lynch 2/ 9/51) and during the winter of 1953-54 when "over 5,000 ducks, mostly mallards, might have been lost. We are always more concerned about the number of birds that might have picked up lead---but gone elsewhere to die. While this source of loss is never conspicuous, to us it is the most appalling aspect of lead poisoning." (Report by Lynch 4/20/54).

An interesting aspect of the heavy losses on Claypool Reservoir is that this area is lightly shot and almost certainly the birds are finding the lead elsewhere.

Negative reports were received from Big Lake, Holla Bend, and Wapanocca NWR and from the GMA at Little Rock.

It is not certain how to classify the following report from GMA Pursley of Pine Cliff: "Negative report from my files and experience during the past three duck seasons in this district. Kill from over-eating of dry beans probably causes greater losses." We assume he is talking about crop impaction which is commonly associated with lead poisoning.

Mississippi

"In my opinion lead poisoning could occur in some areas here---areas like the Sunflower Mgt. area, Smarkey Bayou Hunting Club, and Mathews Brake, and perhaps others where the hunting is confined to the same areas each year. Otherwise, the shooting is too scattered and the lands being shot over are cultivated, thereby reducing the chance for birds to pick up the lead pellets." (L. M. Martin, GMA).

Negative reports from Gulf Island, Noxubee, Yazoo NWRs and GMA at Jackson.

Alabama

"The report for Alabama is negative." (H. W. Beshears, Jr., Wildlife Biologist).

"There have been no outbreaks of lead poisoning here and we have no file data. However, we have, in the past 10 years encountered occasional dead and sick birds and suspected lead poisoning. These include about a dozen crop-impacted Canada geese and perhaps 50 ducks... The nearby Swan Creek Public Hunting Area is heavily shot and should pose a lead poisoning hazard, but yearly cultivation may bury shot out of reach." (T. Z. Atkeson, Wheeler NWR.)

Negative reports from Choctaw NWR and from GMAs stationed at Montgomery and Hartselle.

Louisiana

Apparently lead poisoning has caused mortality among waterfowl wintering in this State for many years. Phillips and Lincoln (1930) gave this interesting account: The great coastal marshes of this State, which are the winter home of myriads of wildfowl, are extremely deficient in sand and gravel, and as they are justly famous shooting grounds, it is not surprising that the birds that congregate there pick up lethal doses of lead in the form of expended lead. The affected area is in the rice belt and a fanciful theory advanced by a local resident was that the birds had acquired the human disease known as beri-beri, which is brought on by a heavy rice diet. Press statements in January 1925 reported "...thousands of ducks dying, and as it was though that the malady was contagious it was feared that it would spread over the entire State. People were warned not to eat waterfowl during that season. All the birds that were picked up and examined by specialists competent to pass on the trouble were found to have died from lead poisoning due to ingested shot."

Judging from a report by Bureau Biologist John Lynch in 1949, "...swamp ducks as well as those using the rice belt sometimes become lead poisoning victims in Louisiana. Trappers in the Lafourche Swamp near Swartz reported in early January that they were noting as many as 50 dead ducks per day. According to Lynch: "we found that this duck sickness was due primarily to lead poisoning. Swamp ducks, particularly mallards, normally would feed on acorns at this season of the year. However, the mast crop in this area was poor this year and low water forced the birds to congregate in the cypress 'brakes,' where they fed on delta duck potato. In digging for tubers--- they picked up quantities of spent lead shot. ...we estimated that at least 1,000 ducks, mostly mallards have already been lost (and) we anticipate that at least "several hundred more birds will eventually succumb."

Catahoula Lake in central Louisiana has a long history of lead poisoning. An old-timer, E. W. Plummer of Jena, reported it has been a problem since 1898. Dr. E. R. Kalmbach reported on a die-off there in 1930.

In January 1951 Lynch reported to Major Brown then Director of the Louisiana Department of Wild Life and Fisheries, that, "...not less than 1,500 birds succumbed. The toll may have been much higher, but evidence of this has been erased by predators. The mallard was the principal bird affected."

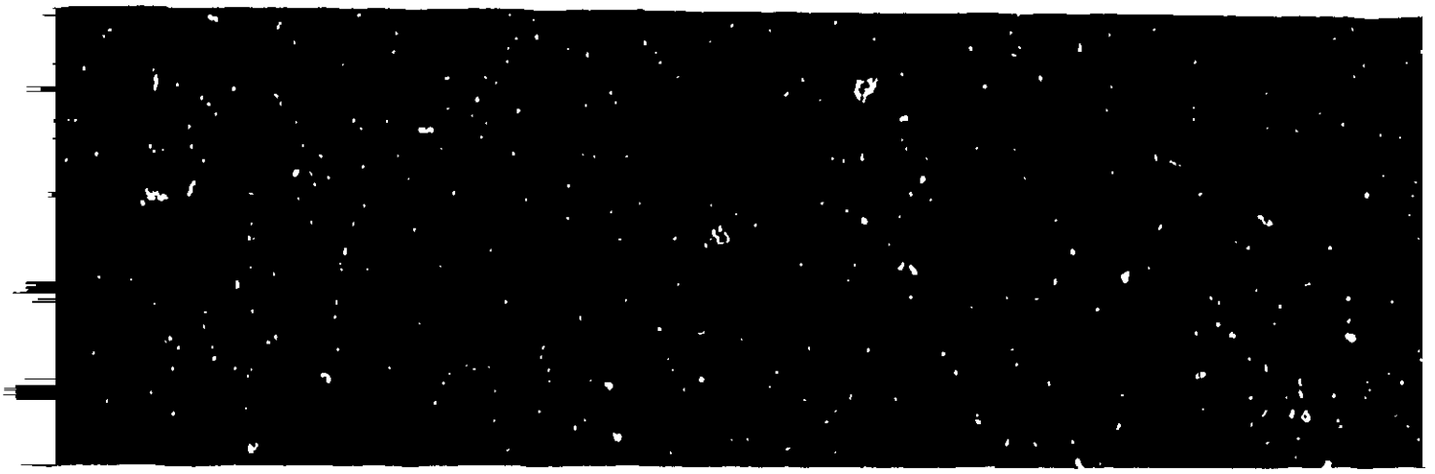
Yancey (1953) in reporting on an outbreak at Catahoula in January and February 1953 stated that "more ducks were lost from this cause (lead poisoning) than were killed by hunters during the 1957 hunting season" (on that lake). Said Yancey when some suggested draining the lake: "Lead poisoning occurs in many other places in Louisiana as well as throughout the United States but this is certainly not a just cause for destroying each individual area. The only large scale solution to this problem lies in using a different type shot--one that will not kill ducks if ingested while feeding."

In January 1964 Lynch wrote: "A nasty outbreak of lead poisoning is raging this winter, among waterfowl of Catahoula Lake." State Research Leader, R. H. Chabreck, prepared a detailed report on this outbreak, estimating that there were 3,325 affected birds at the time of the study including about 725 dead. "...The number that died, washed ashore then eaten by hogs would probably be about 2,000. Should the conditions present at the time of this survey continue, the figures presented here will probably be repeated monthly,--the mallard--made up about two-thirds of those affected. The pintail was second--. Six other species were found in small numbers." Later reports on the same die-off by GMA Carlton and Refuge Manager K. A. Maynard placed the total at 10-12,000. Maynard also reported that 2,200 ducks died there the previous year.

An example of a less spectacular type of loss is afforded by a small unnamed lake near Gueydan. Two local residents reported to Lynch on March 27, 1963, that they had noted some sick canvasbacks. Migration was almost over but about 30 sick cans failed to leave. Five were captured and their gizzards were pumped each yielding 2-7 shot.

Geese have not escaped. A report by Lynch dated 2/17/55 stated: "...The first week in February blue and snow geese were reported dying in the Gum Cove region north of Sabine Refuge (near Vinton). Sick and dead birds were found in the ricefields and pastures---. The Sabine specimens showed all the typical symptoms of lead poisoning. --Lead shot in gizzards range from 3 to 9. --Blue and snow geese are not usually exposed to serious lead poisoning because they--ordinarily frequent marshes where accumulations of spent shot is unlikely. During the past decade, however, these geese have been moving inland into the ricefields of southwest Louisiana. Once they leave the sandy beaches of the Gulf, they have trouble locating convenient sources of grit in the prairie soils of the Louisiana Rice Belt." Some losses of blues and snows are indicated in the files of Lacassine NWR in 1955 and 1956." (Refuge Mgr. J. W. Pullium, Jr.)

Miscellaneous reports include one from H. M. Smith, Atlantic Flyway Biologist, of an outbreak near Jennings about 1954 involving about 1,000 ducks. He also gave the results of a food habits study of 85 ducks of 5 species collected from Plaquemines Parish in 1951. "Based on gizzard and crop analyses, 18 (21%)--contained lead shot. Of interest was the fact that these ducks were taken in an area with no known history of lead poisoning. The pond bottoms are extremely soft over the whole area and I would not expect shot to be deposited in such a manner as to be readily available to feeding



ducks. Of course, the birds could have picked up the shot elsewhere." State agents reporting to GMA J. W. Perroux, stated, "...no recent outbreak--last one of any size was in Langley Marsh 5 miles north of Welsh in 1953-54--4-5,000 birds died, most were mallards, pintails, and teal. This marsh has been drained and is now planted to rice. No doubt birds are picking up plenty of shot and dying somewhere else..."

Negative reports were received from Delta and Sabine NWRs and GMA at Morgan City.

Mississippi Flyway Summary

Bellrose (1959) stated: "A survey conducted (in 1955) among state and federal conservation agents and agencies indicated that in recent years the waterfowl losses from lead poisoning have been largest in the Mississippi Flyway..." Reports from our recent survey suggest that this is still true. Few people to date have made a special effort to document the occurrence of lead poisoning yet many reports have been written about this subject. That it is a common cause of mortality among ducks, geese, and swans using this Flyway and has been for a long time appears evident.

Records appear to be more numerous for the mid-fifties than for recent years. This is to be expected because shooting pressure the past two or three years has been cut in half as compared with that of a decade ago. A return to heavier shooting as duck populations improve, will increase the potential for birds to pick up shot while feeding or graveling, and losses will again become more noticeable.

The next upswing in duck populations is not likely to be as large as that of the fifties, hence it is more important now than it was then to reduce wastage such as that caused by ingesting spent shot.

CENTRAL FLYWAY

North Dakota

"Near Oakes 7/62. One green-winged teal. This would be a rare occurrence in North Dakota as shooting on potholes is more scattered than in the clubbed areas farther south. Several cases of swans dying of lead poisoning--but no records have been made of them to my knowledge. Most waterfowl shooting in North Dakota is done on passes or in fields where the lead shot is not available as it would be in water areas." (V. A. Blazevic, GMA).

Nelson County (Black Swan L.) 1943. "...I do not recall any large outbreak of lead poisoning in North Dakota. However, two dead mallard ducks--were posted--and it was determined that they had died from lead poisoning." (H. A. Jensen, GMA).

"No important losses to lead poisoning have come to our attention in this area. During the late 1930's and early 1940's emaciated birds around winter water holes regularly had lead in the gizzards (these mostly mallards)." (M. C. Hammond, Wildlife Mgt., Biol.)

"I have no reports of lead poisoning in causing waterfowl mortality in North Dakota." (C. H. Schroeder, State Waterfowl Biologist).

Why? Refuge Manager Bradley lists the following four factors: "(1) location in extreme northern part---where waterfowl have less chance of obtaining lead shot before reaching this area (2) many of the normal shallow bodies of water in widespread territory, both U. S. A. and Canada where lead shot might be readily available have been dry during recent years (3) a high percentage of fall migrants feed almost exclusively in stubble or grain fields on uplands where it would be difficult to pick up lead shot (4) waterfowl generally do not linger long during the fall in this area after permanent ice forms. Prior to such conditions the birds are widely distributed and small numbers of lead poisoned birds could easily go undetected."

"No direct evidence of lead poisoning has been observed in North Dakota. However, loose flocks of non-breeding diving ducks including redheads, canvasbacks, lesser scaup, and ruddy ducks have been recorded on some of the larger potholes and lakes during the breeding season. The plumage of these birds often appears quite bedraggled when compared to birds in full breeding condition. Since many of these birds probably winter in the Chesapeake Bay area, it is possible that this condition may be due in part to lead poisoning. It would probably be worthwhile to collect a series of these birds for examination." (R. E. Stewart, Wildlife Research Biologist).

Negative reports from these refuges and areas: Arrowwood, Turtle Lake, Tewaukon, Lostwood, Devils Lake, Minot, Upper Souris, Des Lacs, Long Lake, Jamestown, and Slade.

South Dakota

Red Lake, 2/13/59. "We estimated that perhaps 100 or more Canada geese had died and there were several geese around the open water which were unable to fly and more which appeared to be sick; in addition there were some sick mallards. ...we examined six of the geese--and found 15 shot of varying sizes, all of which (were) considerably worn down.--- It appears that there may be a considerable deposit of shot in Red Lake...." (J. H. Stoudt, Wildlife Res. Biol.) Same outbreak reported by D. R. Progulski, S. D. State Univ.

The following information comes from a food habits study involving 582 gizzards from 16 kinds of waterfowl collected during 1950-51 in Brown, Brookings, and Clark Counties. Nine of 399 mallard stomachs contained one or more shot and three of 183 other kinds of ducks and geese or about 2% of the sample. That same winter 1,012 mallards were fluoroscoped at Lake Andes Refuge and 2.4% contained gizzard shot. The following winter 1,057 mallards fluoroscoped at Coxy's Lake in the Black Hills had a 5.1% incidence of lead leading to the conclusion "although lead poisoning has not reached dangerous proportions at Coxy's Lake, it represents a steady drain on the population. While a portion of the birds now sick will die, they will be replaced by other ducks picking up spent shot, and the population as a whole suffers." (Information supplied by R. D. Hart, State Waterfowl Res. Biol.).

Lake Andes NWR: Refuge reports for the winter period 1954-63 reveal almost annual losses of mallards of from 50-1500. "The loss is a continuing thing throughout the wintering period and is difficult to estimate as predators and scavengers clean up the carcasses about as fast as they die. Casual examination of the bottom in the vicinity of the artesian well (the focal point of the losses) revealed minor amounts of shot. --some of the birds examined showed as high as 50-plus shot in the gizzard indicating to me that some of the birds obtained the shot elsewhere and came into the unit during the early stages of effects. At any time during the winter there are sick ducks in the well area--most of these do not recover. We accept the loss as a continued, annual phenomenon about which little can be done." (H. W. Miller, Wildlife Biologist).

One thing that bothered me about such losses (referring to these at L. Andes)--is just how accurate our guess as to the number of deaths might be. Lead poisoned birds have a tendency to crawl into the heaviest cover available before dying, making it difficult to estimate the total loss (L. Kirsch, Wildlife Res. Biol.)

Sand Lake NWR 1951: "Number affected - 700 mallards (actual count) 3,000 (estimated). Of 125 hospitalized, 60% died. Estimated that half of the 10,000 ducks remaining on Dec. 20 were suffering from lead poisoning."

1951: "Following one such period (cold & blowing snow), over 500 dead mallards were counted within a 100 yd. radius of a water hole. An estimated 3000 mallards died indirectly from lead poisoning--in the vicinity of one

water holes. --there were three such water holes open until December 10 which harbored about 46,000 mallards, many of which were carrying ingested lead shot." Species affected; 6: Numbers affected, 3,000 (actual count), 10,000 (estimated). Remarks: The apparent large number of lead poisoned birds, chiefly mallard is no doubt the remnant of the more seriously affected portion of the flyway population that moves through the Sand Lake area during the fall migration."

1952. Ducks suffering from lead poisoning contracted outside the refuge began to show up during the middle of November. ---It is estimated that approximately 1,000 ducks died from the disease---. The exceptionally mild weather permitted more ducks to recover..."

1953. "It is estimated that not more than 100 ducks died on the refuge, and no more than 600 were affected."

1954. "Again this year lead poisoning among our late December mallards was noted. --It was estimated that there were 250 dead birds around that area. About 400 mallards and a few of the redheads would not or could not flush from the open water hole."

1955. "No evidence of lead poisoning was noted."

1956. "..no evidence was found of birds suffering from the effects of ingested lead."

(The above are extracts from Sand Lake reports for the period 1950-56.) Older records show almost annual losses of consequence back to 1935 when J. J. Lynch examined 113 dead mallards found around two water holes after an early freeze and 91 contained shot in their digestive tracts. Manager Schoonover summarizes the recent period 1959-64 as follows: "Small losses occur each November. Normally the loss is estimated at about 250 birds." This then exemplifies a chronic trouble spot for lead poisoning yet the area has been a refuge since 1935. Furthermore, any lead deposited prior to that time is now covered with a silt layer 1-3 feet deep. The victims, therefore, must pick up the lead some place else.

Negative reports from following places: Garrison Dam, Aberdeen, Spearfish, Waubay, Huron, Lacreek, Mitchell, Yankton, Brookings, Pocasse, Pierre.

Nebraska

Bellrose (1959) quoted a letter from G. V. Schildman as follows: "The numerous rainwater basins in Clay, Fillmore, and York Counties provide some losses each spring--the losses are commonplace, but to my knowledge--haven't been conspicuous and concentrated. However, these basins cover an extensive area, and the total loss may be significant."

"3/18/64. Lead poisoning suspected and indicated in die-off (of about 300 mallards and pintails), Platte River, Overton area. Specimens collected

and forwarded to Bear River and Patuxent Research Stations. Diagnosis not yet received. Lead poisoning--does not appear to present too much of a problem thus far. The above mentioned cases (including Capitol Beach Lake at Lincoln some years back) are the only two known to this writer..." Hunting pressure within the state is confined primarily to the Platte River Valley, Rainwater Basin, Sandhill lakes and the Missouri River and is spread out and changeable from year to year, thereby eliminating the possibility of the concentration of shot within a given area." (L. J. Bondc, GMA).

Bellrose (1949) lists losses of about 600 blue and snow geese on two lakes (Salt and Capitol Beach) near Lincoln during March and April 1945 and 1951-53. A pintail found dead near Burwell was examined by Biologist Schwilling and found to contain 14 gizzard shot in various stages of erosion. Records of the Valentine NWR show a minor loss among redheads in 1945 and 1946.

Negative reports were received from Crescent Lake NWR, the GMA at Hastings, the River Basins office at Grand Island, and the Nebraska panhandle concerning which State Waterfowl Biologist J. T. Sweet says: "I do not believe that we on this area are subject to the malady to the extent that it would cause any concern. We do not have the concentration of shooters on our Sandhill lakes, rivers, and streams..."

Kansas

Phillips and Lincoln (1930)* tell about the death of large numbers of mallards, pintails, and teal near Riverton during February 1923. Lead poisoning was held responsible but not shot pellets. Water contaminated by refuse from lead mines was blamed.

Bellrose (1959) recorded a loss of 200-250 mallards on Reeves Lake in Grant County during January 1953.

"I have no record of lead poisoning in Kansas" (M. D. Schwilling, Waterfowl project leader).

"I have seen no evidence of lead poisoning on or near the Quivira NWR--however, there should be a high potential for it in this area as the water areas have been hunted over by private clubs since the early 1900's. One reason for our not having seen evidence of sick ducks is the high population of predatory animals and bald eagles (during waterfowl concentrations). Before a duck gets sick enough for us to notice he has been featured on the menu of an eagle, coyote, skunk, etc." (J. J. Harmon, Quivira NWR).

Negative reports received from Kirwin NWR and Topeka.

Oklahoma

"Minor losses could go undetected as all dead and crippled birds are taken by eagles and coyotes during the periods of heavy concentrations. Duck hunting is not heavy in the immediate area." (R. J. Hitch, Salt Plains NWR)

Bellrose (1959) quoted R. E. Griffith's letter of 4/1/55 as follows: "Minor losses have been reported from Salt Plains Refuge..."

Negative reports received from GMA Frazier and Washita and Tishomingo NWRs.

Texas

American Field for March 24, 1894, gave notice that two lots of ducks killed at Stephenson's Lake had been seized and condemned by the health officer at Galveston. Reason: unfit for food because of lead shot "disease" which already had been noted for twenty years. (Phillips & Lincoln 1930).

Bellrose (1959) lists a loss of 160 ducks at Muleshoe NWR in December 1946 attributed to lead poisoning and another in Aransas County in January-February 1949 involving 100 scaup.

Lubbock 1946. 876 victims of lead poisoning counted. "This condition resulted in the skeet range over a playa lake--. Perhaps 90% of the lead shot landed (in) the lake, dry much of the time but with good rains--a suitable place for up to 10,000 migrating ducks. ..the condition was corrected by deep plowing (about 14 inches). (F. A. Thompson, GMA).

Jefferson Co. (Big Hill Bayou) Dec. 1961. During a die-off 11 specimens were collected for study: 4 blue geese, 1 snow goose, 1 shoveler, 3 pintails, and 2 teal. The gizzards of five of these birds contained shot and another bird without gizzard shot had all other symptoms of lead poisoning." In the area---we have had several outbreaks of sick and dying waterfowl in the past, and on one occasion several hundred dead waterfowl were taken from one hunting club area. These outbreaks occurred when the water levels were low and--where hunting pressure is great." (G. J. Nun, GMA).

This same area had a loss in early 1963 estimated at 2,000 mallards and pintails by M. J. Camery, GMA.

Messrs. Singleton and Beasley, Texas Parks and Wildlife Department, reported as many as 1,000 sick blue and snow geese in the vicinity of Sheldon Waterfowl Mgmt. Area, Harris County, the forepart of Dec. 1960. Preliminary analyses performed by Texas A & M College indicated lead poisoning. Posting of a juvenile blue goose picked up on the management area Dec. 7 revealed impacted crop and proventriculus and the remains of twelve (12) lead shot in the gizzard. Singleton and Beasley theorized that affected birds must be acquiring lead shot during the fall migration. (R. J. Buller, Central Flyway Representative)

Negative reports were received from the following areas: Laguna Atascosa, Aransas, Hagerman, Anahuac, Buffalo Lake, Muleshoe NWRs, and from GMAs at Corpus Christi, San Angelo, and Victoria.

New Mexico

Reports all negative from Bitter Lake, Bosque del Apache, and GMAs at Albuquerque and Roswell.

Colorado

"...does not seem to be important in Colorado probably because of lack of concentrated hunting. Most of our hunting clubs are on the river where lead shot is washed away." (J. R. Grieb, Asst. Game Mgr.)

"Some waterfowl die-offs did occur on the refuge from 1953 through 1960. It is expected that a few birds are still dying off due to lead poisoning, particularly in areas in the valley where gun clubs have been in operation for some 30 years, but we do not have any specific information regarding this." (C. R. Bryant, Monte Vista NWR).

Negative reports from GMAs at Grand Junction and Denver.

Wyoming

"No reports or records." (J. F. Wrakestraw, Supervisor Waterfowl Mgt.)

Negative report also for Hutton Lake and Pathfinder NWRs.

Montana

"...I have come in contact with lead poisoning in waterfowl a number of times. In one instance--a swan-- gizzard (contained) 34 shot distinctly numbers 4, 6 and 7½ size shot and others too fine to recognize. I have doctored a number of Canada geese..." (E. L. (Sam) Mitchell, Polson, Mont.)

"We have observed lead poisoning in from 1%-2% of the wintering population of mallards which numbers annually from 5,000 to 30,000 birds. Obviously, lead ingested by these birds is picked up in other locations---possibly at some of the marsh areas in Canada or, for that matter, on refuges such as Bowdoin, Medicine Lake, or a few of the other marsh areas that have been shot over 50 years or more. ---Lead poisoning is a very familiar disorder to the refuge manager and was first observed (by me) at Bear River Refuge in the early 30's. It has appeared again on assignments for more than 30 years and undoubtedly is a mortality factor that cannot be ignored. --The Central Flyway at least that portion of it at this latitude, probably sees fewer leaded birds than any other portion of the United States." (F. T. Staunton, Chas. M. Russell NWRange).

Helena 2/10/64. Drainage from lead ore piles resulted in the death of about 35 mallards according to GMA W. A. Brann. The situation has been corrected.

Negative reports were submitted from these areas. Medicine Lake, National Bison Range, Billings, Lewiston, Bowdoin, Fairfield, Benton Lake, and Red Rock Lakes. However, Banko (1960)* tells of recovering 4 trumpeters which died on their refuge feeding grounds at Culver Pond during late March and early April 1937. Laboratory diagnosis indicated that lead poisoning caused their deaths.

Central Flyway Summary

Losses in this Flyway from lead poisoning seem to be mostly scattered and therefore difficult to evaluate. Only South Dakota among the 10 States of this Flyway has chronic trouble spots, according to the reports submitted. But why South Dakota, and why have the outbreaks been on refuges where hunting is not permitted? Hunting pressure in that State is not as great as in some of the others and the type of hunting which prevails would seem less likely than in some other places to result in heavy concentrations of shot. Lake bottoms are not much different than they are elsewhere, in relation to pellet availability to waterfowl. The answer must be more obscure.

One clue is that die-offs become noticeable when lakes become ice-bound, except for open holes. This means that birds which have lingered behind the main flight become highly concentrated. When the birds concentrate on refuges they are seen and when they are sick or die under these conditions, they are noticed. Sometimes the birds are forced into situations where lead shot is available but other times it had to be picked up at some other place.

It seems reasonable to conclude that there are significant numbers of birds in the Central Flyway population containing ingested shot but this fact becomes known only under special conditions such as stress periods or when special studies are made. Since little effort has been made to date in this Flyway to evaluate the lead poisoning problem, it is not surprising that records of its occurrence are relatively few. That the potential exists in various parts of the Flyway, however, is evident.

*See bibliography

PACIFIC FLYWAY

British Columbia

Bellrose (1959)* tabulated the incidence of lead shot found in nearly 40 thousand gizzards collected in the United States and Canada. The highest rate found outside the Mississippi Flyway was from a small sample obtained by Malyshkff (1951) in the Lower Fraser Valley of British Columbia.

"In British Columbia, the problem of lead poisoning among wintering flocks of trumpeters has presented a recurring threat. J. A. Munro (1949) documented the loss of at least 9 trumpeters of the Vaseaux Lake wintering population of 1925. ---The stomach contents of 1 of these victims contained 451 shot. ---Munro also records the loss of at least 13 trumpeters from a flock of 25 wintering on Vancouver Island in 1946. The stomach tracts of these victims held from 2 to 29 pellets each." Binko (1960)*

Alaska

Juneau, 1962 to date. "The contaminated area is one small pond over which the trap shooting is done. --The attractiveness of this specific pond over the others for transient waterfowl is its gravel bottom whereas most of the others are fine glacial silt. After only 3 years of use by the gun club, the bottom of the entire pond is quite literally paved with lead shot--almost an inch in the area of concentrated fallout. The potential for waterfowl here is very great--upwards of 50,000 during each spring migration and perhaps a similar number during the fall. Species involved: Canada geese, mallard, pintail, widgeon, green-winged teal, scaup, goldeneye, and buffle-head." (H. A. Hansen, Waterfowl Supervisor).

Speaking of Alaska generally, I doubt that lead poisoning is a serious factor. Some exceptions may occur in the Cook Inlet area where a few ponds may have been used for several years." (D. L. Spencer, Wildlife Refuge Supervisor).

Negative reports from Aleutian Islands NWR, Fairbanks, Anchorage, Kodiak, Ketchikan, Clarence Rhodes NWR and Kenai.

Washington

"Since 1960 heavy waterfowling pressure has occurred in the developed marsh unit I and an occasional waterfowl loss (less than five percent) has been attributed to lead poisoning. We would assume that with continued heavy annual public hunting use of this shallow marsh, the frequency of ingested lead and resulting loss will increase. To our knowledge, waterfowl mortality from lead poisoning has been non-existent or extremely low throughout the Columbia Basin of Central Washington." (P. A. Lehenbaurer, Columbia NWR.)

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*See bibliography.

"I have heard rumors--of divers dying on the shores of Bainbridge Island in September of 1963. Lead poisoning was suspected." (H. L. Cantrell, GMA)

"Areas around Puget Sound are potential problem areas--because of heavy soils and intensive shooting on some club areas. (J. E. Chattin, Pacific Flyway Representative).

Negative reports from Turnbull NWR, Willapa NWR, McNary NWR, Little Pend Oreille NWR, and GMA's stationed at Moses Lake and Seattle.

Oregon

"In my opinion lead poisoning in the eastern part of Oregon--is not and never will be very serious." (F. E. Kreller, GMA).

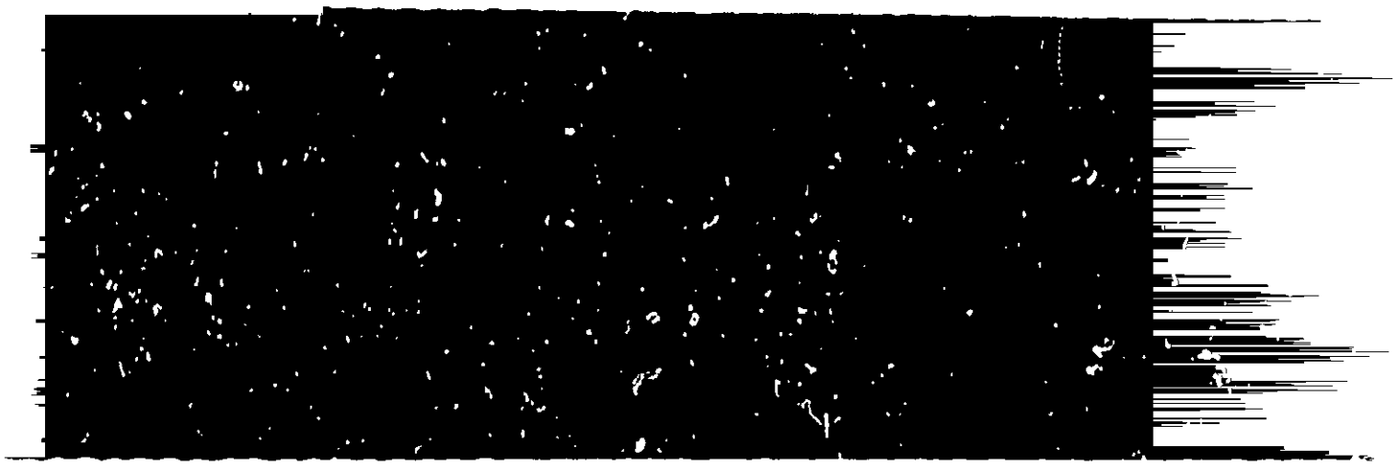
"...there is no doubt that lead poisoning is the cause of a moderate loss of waterfowl in this area, especially on the marsh areas of the public shooting grounds in the Tule Lake-Lower Klamath areas." (W. Fuchs, GMA).

"...most losses from lead poisoning usually were from the high water years when small outlying basins, normally dry, were flooded--. Bottoms of most of these playa lakes are firm and there is little sinking of shot into the mud. Although most of the ducks passing through were pintails, mallards, and other puddle ducks, the preponderance of casualties fell into the diving duck group. A few whistling swans were also lost. --not over 500 birds were lost most years with this number rising to 1,000 birds, primarily canvasbacks, redheads, and lesser scaup, during the most severe years, or about 1 year in 10. (1942 an especially bad year). --at Malheur Refuge I think it unlikely that it accounts for more than 2 to 4 percent of the birds traveling through the area, probably much less. However, even if only 1 percent were lost, and this mortality rate were repeated at several other locations along the Flyway, it would not be long before the proportion could become a significant drain on the population." (R. C. Erickson, Res. Staff Specialist).

"Eastern Oregon areas, such as Summer Lake, Warner Valley, etc., would not be a serious problem because they dry up in drought years and blow sand and dust or heavy vegetative growth makes shot unavilable." In western Oregon, we have some slight problem on small club areas which have heavy soils and permanent ponds. Sauvies Island, the State public hunting area, does not appear to be a serious problem because of cultivation and annual spring flooding which overlays much of the area with silt. (J. E. Chattin, Pac. Flyway Representative).

"The only known instances---that have come to my attention--Sauvies Island Management Area and the Tule Lake, Lower Klamath NWR system." (T. Garratt, GMA).

Negative reports from Summer Lake and Lakeview.



California

Bellrose (1959) recorded the loss of 9,000-10,000 pintails in 1939 on San Francisco and Suisun Bay areas and 4,000 pintails and green-winged teal during the winters of 1944-54 at Salton Sea NWR.

"Lead poisoning of ducks in California might be described as a chronic condition. It is present, but not in large die-offs. ...the main areas where lead poisoning occurs are those that have the most hunting. These include Tule Lake, Sacramento Valley, mainly around the Butte Sink; Suisun Marsh, San Francisco Bay, San Joaquin Valley, mainly the Grasslands; and the south end of the Salton Sea." (F. M. Kozlik, Waterfowl Coordinator).

"The most important waterfowl areas include the Sacramento, San Joaquin, and Suisun Marsh areas where lead poisoning is and will likely continue to be somewhat of a problem. These areas are intensively shot by gun clubs and this heavy shooting has continued since the early 1900's. Pond bottoms in many instances are heavy, impervious clay and relatively hard. In such situations lead shot persists in availability over a long period. This area generally is probably the most lethal of all stateside areas.

"Managed public shooting areas in these localities are probably less hazardous because of pond and crop rotation and cultivation which reduces availability of spent shot. The same would be true for the Tule-Klamath area or others where pass shooting or field shooting is the common practice. San Francisco Bay proper, I would not class as a problem area, but some of the adjacent fresh or salt water ponded areas in the South Bay or marginal areas may kill some ducks." (J. E. Chattin, Pacific Flyway Representative.)

"Solano Co. (Suisun Marsh) 1963. 300-400 ducks lost" (C. P. Stribling, GMA).

"I suspect that considerably more lead poisoning has taken place than has been given credit in some of these losses as they occur in the vicinity of hunting areas, and in situations which would be indicative that lead was being ingested." (A. E. Weinrich, GMA)

Butte, Colusa, Sutter, Glenn Cos. "Each, after the close of the waterfowl season, waterfowl are reported and observed in sick and dying condition throughout the duck club area in the above counties. Many deaths have been confirmed as lead poisoning by technicians from the California Fish & Game Department. In the San Joaquin-Sacramento River Delta area, there is an annual loss due, mainly to fowl cholera; however, some deaths have been attributed to lead poisoning." (J. E. Downs, GMA).

Negative reports were submitted from the following localities: Merced NWR, Kern and Pixley NWR, Modoc NWR, Sacrament NWR, Salton Sea NWR and for GMAs at Tulelake, Chico, Fresno, Pasadena, Bakersfield, San Diego, and Merced.

Nevada

"To the best of my knowledge there has been no serious incidence of lead poisoning in waterfowl in Nevada. Although most waterfowl hunting is done on State and Federal public hunting areas, hunter density is relatively low. ...As hunter density becomes higher--lead poisoning could possibly become an important cause of waterfowl mortality in the future." (C. R. Oglesby, Nev. Fish & Game Dept. and R. C. Watson, Stillwater NWR

Negative reports received from Ruby Lake NWR, Desert Game Range, Pahranagat NWR (new in '64), and the northern district. The southern district also submitted a negative report but GMA Wilson added: "Waterfowl hunting in this area is--restricted to a few thousand acres. As populations--increase (lead poisoning) may become more evident here. ...more and more pressure is being placed on these areas."

Arizona

"Generally light gunning pressure and type of habitat appear to indicate no problem with lead poisoning." (J. E. Chattin, Pac. Flyway Representative).

Negative reports received from Havasu Lake NWR, Kofa and Cabeza Game Ranges and Imperial NWR.

Utah

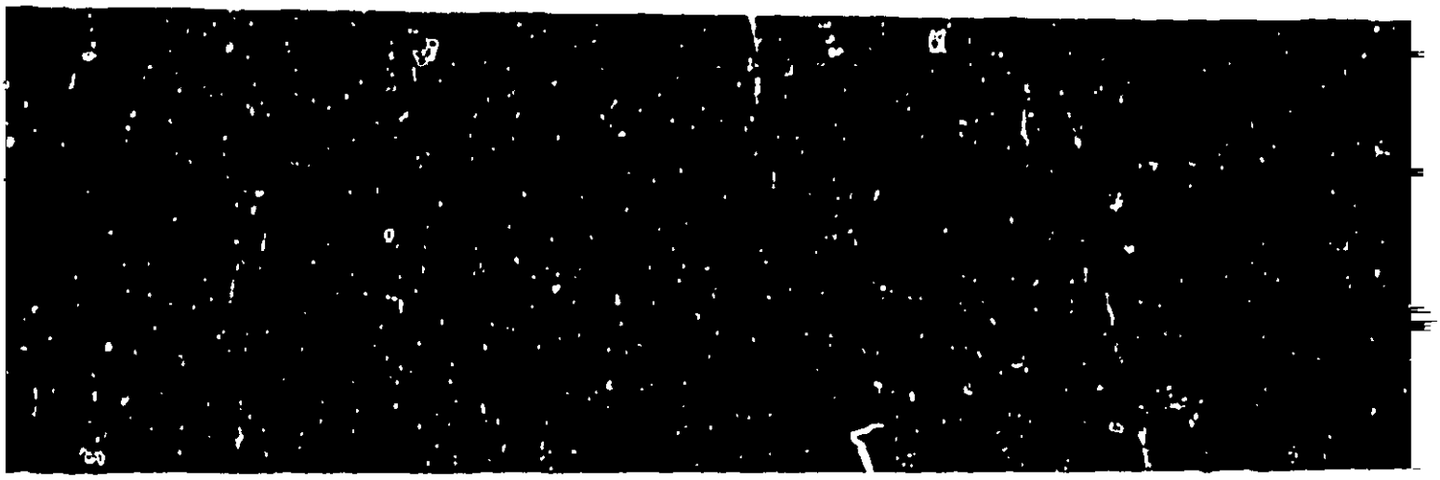
This State was the scene of the first lead poisoning study, that by Dr. Wetmore in 1916 at the mouth of the Bear River. Using a sieve he obtained bottom samples which revealed the presence of a considerable amount of spent shot within easy reach of feeding waterfowl.

Davis County (New State Gun Club) Jan-Feb. 1955. "Estimated 250 whistling swans lost. This club is heavily shot---. During severe cold weather, most of the water covered with ice and several hundred swans congregated on a small area of open water at the confluence of the Jordan River and Gun Club Lake. --Undoubtedly, this same condition of heavily concentrated feeding occurred other places----."

4/28/48. "Several swans died in the vicinity of Syracuse, Davis County. Dr. Jessop Low made a stomach analysis of several dead birds and stated all died of lead poisoning."

3/8/55. "During recent weeks, several whistling swans have died on the Newstate duck club. (Club manager Johnson (claimed) he picked up 641 dead swans during March of 1955.)

"...since 1958, we have had little or no loss attributed to lead poisoning on ducks and geese; (but) up to two dozen whistling swans." (W. E. Ritter, GMA).



"From our obs rvations and past records we feel that the extent and importance of lead poisoning in causing wate fowl mortality at Bear River Refuge is very minor. While we do know that we have some losses from lead poisoning at the refuge the available information is rather meager and questionable. It is difficult to diagnose the cause of death when large numbers of dea waterfowl are being piled up during periods of botulism outbreaks. Undoub dly, lead poisoning is a contributing factor, however, to what exten is unknown. ...we have felt that the actual losses--from lead poi-ning were relatively small even though a considerable percentage of the waterfowl may ingest som ad from time to time." (V. T. Wilson, Bear River NWR).

"Bear River and Ogden Bay Refuges 1957-58. Dr. Malcolm E. McDonald--and I examined 58 swans--in connection with my mas er's study. We found that ten birds had definitely died of lead poisoning. All ten were juveniles. ...one bird had ingested 236 lead pellets and another--152. It was not uncommon to find other waterfowl so affected at Bear River Refuge--. It was my impression that the losses were significant, and even more so on some of the private hunting marshes closer to Salt Lake City.' (G. A. Sherwood, Wildlife Biologist).

Letter from Dr. Je sop B. Low of Utah State University, dated 4/23/64: Speaking of lead p isoning: "This type of loss is going on right here at an insidious rate and I feel this rate will probably increase through the years. This is based on the fact that I have seen limited numbers of waterfowl sick from lead poisoning in past years and that much more lead is being deposited yearly on Utah and the western marshes. Just yesterday I saw a number of redheads at Ogden Bay Bird Refuge unable to fly and if I were to guess this is a result from lead poisoning. However, getting evidence is another matter because the birds with lead poisoning sneak off into heavy cover where they die unnoticed and uncounted."

"To my knowledge, there have been no outbreaks of lead poisoning in Utah. An occasional bird is picked up which is obviously leaded, but the total loss from this cause is certainly insignificant. There is a possibility that under proper winter conditions, where open water persists only on gun clubs which may be heavily shot, that some loss could occur both in ducks and whistling swans. We have suspected that some of the 20 or so whistling swans lost this winter may have become leaded because of their feeding for extended periods in small areas. ...it is unlikely that lead poisoning will become a problem in Utah for some time to come." (D. A. Smith, Asst. Chief, Game--Waterfowl, Utah Dept. Fish & Game.)

Since 1957, Dr. ne I, Jensen, Chief, Section Wildlife Disease Research at Bear River ch Station, has conducted post mortems on 630 waterfowl. Most of the se ns came from Utah but a few were sent in for diagnosis during die-offs Texas and Nebraska. Forty-five or 7.1% of the birds in this sample contained ingested lead. Besides whistling swans, there were 2 kinds of geese, 8 kinds of ducks and a coot represented.

"Heaviest shooting is on the Salt Lake Valley on public shooting grounds and a few clubs. Lead here may be a problem since pond bottoms are fairly solid and no rotation or cultivation is practiced. The remainder of the State I would assume is so lightly shot that no problem areas would be evident." (J. E. Chattin, Pac. Flyway Representative.)

Negative reports received from GMA at Richfield and Fish Springs NWR.

Idaho

Kalmbach and Coburn (1937) reported on their investigation of "starvation" in southern Idaho during January and February 1937. Along 2.5 miles of the Portneuf River near Pocatello they counted 75 dead ducks and along 3 miles of drainage ditches near Boise, 115 dead ducks. On nearby feed fields they noted 42 ducks on approximately 15 acres. They conducted autopsies on 90 birds, of these, the gizzards of 11 contained lead shot. They commented: "..lead poisoning, now considered one of the most insidious factors tending to reduce the wintering flocks, was long misunderstood and its seriousness ignored."

"Most of the State is only lightly gunned and in the more intensively shot areas, lead is a negligible problem because of the character of the areas, i.e., field shooting or river and island shooting." (J. E. Chattin, Pac. Flyway Representative).

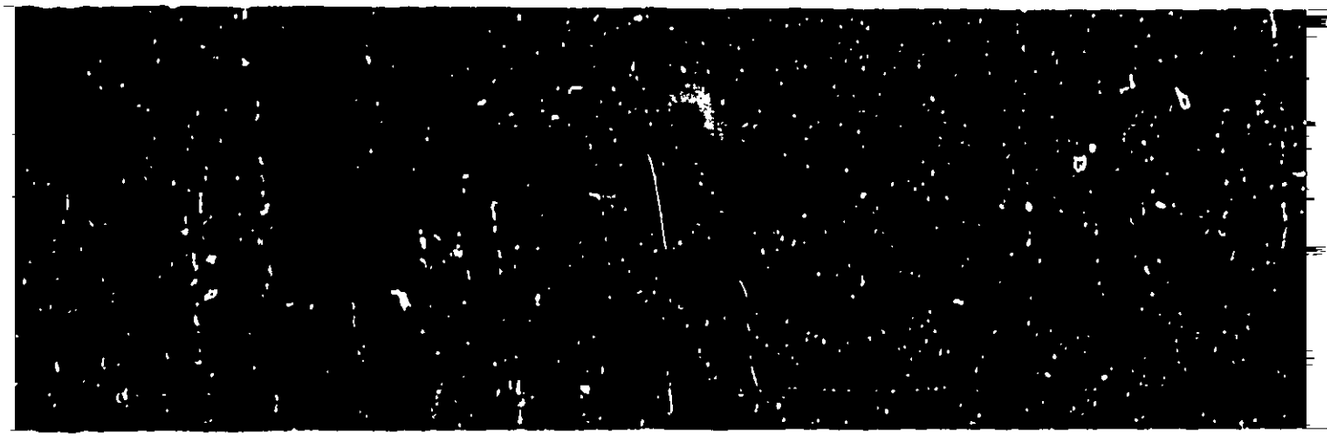
Negative reports received from Deer Flat, Minidoka, and Camas NWRs.

Pacific Flyway Summary

Waterfowl migrating through this Flyway run the risk of visiting an area where lead shot pellets are available to them, just as they do in the other three flyways. Parts of the far west are so lightly shot that lead accumulation on marsh bottoms is widely scattered and does not constitute a serious hazard to feeding wildfowl. But here and there are heavily shot places with firm bottoms which retain lead pellets well within the feeding zone.

As several observers pointed out, lead poisoned victims are easily overlooked in these "wide open spaces". Where massive killers like botulism and fowl cholera are at work, it is likely that many lead victims are included with those chalked-off to these other mortality agents.

Considering the fairly large number of records obtained with little special attention directed at the lead poisoning problem plus the obvious growing potential, it must be concluded that here as elsewhere lead poisoning is an important problem.



DISCUSSION

The foregoing pages present a hodgepodge of facts and opinions on the lead poisoning problem in many areas used by North American waterfowl. What does all this information mean? There are conflicting reports from the same area and every degree of concern expressed about the malady, from none at all to one of extreme anxiety.

In evaluating these reports and the problem involved, several points need clarification. Many of the reports have used the terms potential, incidence, and losses rather loosely. By "potential" we mean that spent lead is available to feeding waterfowl in quantity. So far, "quantity" has not been defined but a rough rule of thumb has been suggested by Jessen and Lound (1959)* as "about 1 shot per square foot in heavily hunted areas and 0.2 shot per square foot in moderately hunted areas..." as an average in a large series of samples. They hasten to point out, however, that "lead shot availability to waterfowl--will be closely related to hunting pressure and nature of the underlying soils (hence) the problem of lead shot incidence will have to be evaluated on the basis of individual areas."

Thus, potential and incidence are used in expressing the degree to which shot is available to the birds. "Incidence," however, is more commonly used to express the number of ingested shot found in the gizzard during fluoroscopy or stomach analysis. But incidence may be related to actual mortality only in a general way. There are many records of lead poisoning mortality, demonstrated by chemical analysis of internal organs or bone cartilage, when incidence was zero (the lead was either ground up or passed by the time of the examination) but the damage already had been done. Conversely, birds appearing healthy have been found with ingested shot. Depending on diets, weather conditions, and species' age and sex differences in ability to resist poisoning, the presence of lead in the gizzard is not directly converted to a figure representing loss.

The geographic and chronological distribution of the problem seems to make little sense. In some cases severe outbreaks were reported in the literature decades ago. Since that time, despite presumably increased hunting pressure in these areas, no additional records have been added. Why?

We believe that one explanation is that outbreaks severe enough to attract attention must be triggered by special conditions. Some observers have reported that low water levels make an outbreak more likely; others have found high water levels set the stage. Report after report points to stress caused by extreme cold and snowstorms which restrict food supplies as conditions which cause large die-offs most often. In a few places across the country, conditions are right for large die-offs almost annually, other places they occur intermittently and still others only rarely. Furthermore, the place where mortality occurs is not necessarily the same place where the shot was picked up.

*Jessen, Robert and Richard Lound 1959. Study of incidence of lead shot in certain marshes and lakes. P-R Job Completion Rept. Minn. W-11-R-19, Job #10.

We agree with those who have commented about the "insidious" nature of lead poisoning.

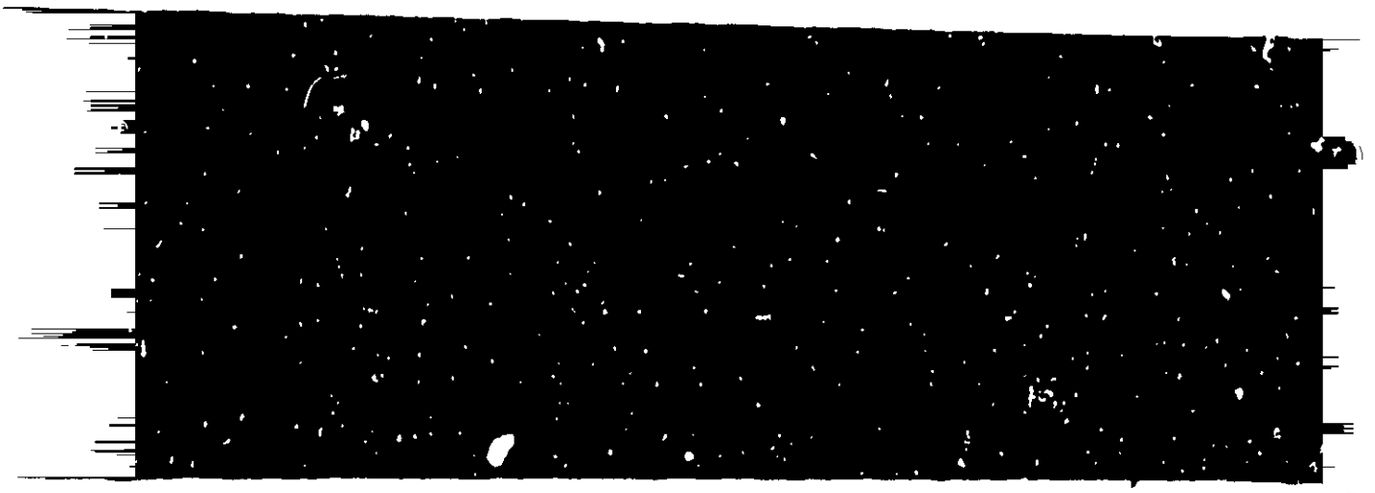
As Frank Bellrose put it (let. 5/6/64), "..We know the high rate of natural mortality in birds, but how often do you find a dead bird? Most waterfowl that die from lead poisoning are never noted. Sick waterfowl seek concealment in the densest vegetation and they seek isolation. Except in hunting season, few people frequent areas where waterfowl occur. Therefore, the attritional losses of ducks from lead poisoning are seldom, if ever, observed. In my opinion, these are the big losses. Large losses---are observed, but even here the magnitude of losses observed are usually minimal, while the actual losses may be considerably greater."

During an average hunting season at least 12 million pounds (6,000 tons) of lead are deposited on waterfowl habitat. Fortunately, much of it falls in deep water, on soft bottoms of marshes or in other places where waterfowl are not likely to find it. But there are places in all four flyways---probably more than we realize---where shot is readily available to the birds. We know from experience that a certain percentage of the shot will be ingested. Under certain conditions, one or more pellets will kill a duck.

Many factors will result in greater or lesser amounts of the total shot deposit to be consumed any given year and the resulting loss rate will vary depending on conditions already mentioned. Some large die-offs---like those at Grant's Lake, Manitoba, Sand Lake, South Dakota, and Claypool Reservoir, Arkansas, areas where shooting has been entirely absent or light for many years---suggest that in the waterfowl population are many individuals carrying lead which will succumb under one set of conditions or survive under another. Or, perhaps they don't survive, but simply die in widely scattered places rather than at one spot. And if birds in that condition do survive, what then? Do they return to full health or are they incapacitated in some way?

Thus the lead poisoning problem, like many others, is difficult to capsulate. It is certainly real, but how big we do not know. There is reason to think it composes a large part of so-called natural mortality.

Some contributors remarked that the problem was unimportant because only one or two percent of the stomachs contained lead shot. They forget that lead is not retained in the gizzard indefinitely. Bellrose (1959) pointed out that "observations in the field and in the laboratory indicate that a mallard that survives ingestion of lead will have eliminated the lead 18 days, on the average, after ingestion; a mallard that dies with lead still in the gizzard will die 21 days, on the average, after ingestion. (Hence) 20 days have been chosen as the average period of turnover of leaded mallards in the wild." Therefore, during a wintering period of 120 days there are 6 turnover periods. This factor should be applied to incidence figures to arrive at the actual rate at which lead is ingested by the population. Using this correction, Bellrose at the time of his study, concluded that one-fourth of the wild mallards of North America ingested shot annually. He further



concluded that "..the annual waste due to lead poisoning among all species of waterfowl in all North American flyways is estimated to be between 2 and 3 percent of the population." This would amount to a wastage of a million or more ducks plus lesser numbers of geese and swans when populations are at normal levels.

In the present study, we have found no basis for rejecting Bellrose's conclusions. Even if losses were considerably below his estimates, they would have to be considered important to our management program by whatever yardstock is applied. The chances may be equally good that he has underestimated rather than overestimated. We, therefore, conclude that lead poisoning is a serious problem and one worthy of considerable effort to solve.

Arthur S. Hawkins,
Mississippi Flyway Representative

July 8, 1964